

Claims

1. A catalyst system comprising an activator and one or more heteroatom substituted phenoxide group 4 to 10 transition or lanthanide metal compounds wherein the metal is bound to the oxygen of the phenoxide group and provided that:

- a) if more than one heteroatom substituted phenoxide is present it is not bridged to the other heteroatom substituted phenoxide,
- b) if the metal is a group 4 metal, the heteroatom substituted phenoxide does not contain pyridine,
- c) if the metal is a group 4 metal then the carbon ortho to the carbon bound to the oxygen of the phenoxide may not be bound to an aldehyde or an ester, and
- d) if the metal is nickel then the carbon ortho to the carbon bound to the oxygen of the phenoxide may not be bound to an imine.

15 2. The catalyst system of claim 1 wherein the activator is an aluminum alkyl, an alumoxane, a modified alumoxane, a borane or a non-coordinating anion.

3. The catalyst system of claim 1 wherein the transition metal is a ^{Group} 4 metal.

20 4. The catalyst system of claim 1 wherein the transition metal is zirconium.

5. The catalyst system of claim 1 wherein the heteroatom substituted phenoxide transition metal compound is an iminophenoxyde ^{Group} 4 transition metal compound.

25 6. The catalyst system of claim 1 wherein the heteroatom substituted phenoxide transition metal compound is an iminophenoxydezirconium compound.

7. The catalyst system of claim 1 wherein the heteroatom substituted phenoxide transition metal compound is selected from the ^{Group} consisting of:

bis(*N*-methyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;
bis(*N*-ethyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;
bis(*N*-*iso*-propyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;
bis(*N*-*t*-butyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;
5 bis(*N*-benzyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;
bis(*N*-hexyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;
bis(*N*-phenyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;
bis(*N*-methyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;
bis(*N*-benzyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dichloride;
10 bis(*N*-benzyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dipivalate;
bis(*N*-benzyl-3,5-di-*t*-butylsalicylimino)titanium(IV) dipivalate;
bis(*N*-benzyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) di(bis(dimethylamide));
bis(*N*-*iso*-propyl-3,5-di-*t*-amylsalicylimino)zirconium(IV) dibenzyl;
bis(*N*-*iso*-propyl-3,5-di-*t*-octylsalicylimino)zirconium(IV) dibenzyl;
15 bis(*N*-*iso*-propyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-*iso*-propyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)titanium(IV) dibenzyl;
bis(*N*-*iso*-propyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)hafnium(IV) dibenzyl;
bis(*N*-*iso*-butyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-*iso*-butyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) dichloride;
20 bis(*N*-hexyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-phenyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-*iso*-propyl-3,5-di-(1'-methylcyclohexyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-benzyl-3-*t*-butylsalicylimino)zirconium(IV) dibenzyl;
bis(*N*-benzyl-3-triphenylmethylsalicylimino)zirconium(IV) dibenzyl;
25 bis(*N*-*iso*-propyl-3,5-di-trimethylsilylsalicylimino)zirconium(IV) dibenzyl;
bis(*N*-*iso*-propyl-3-(phenyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-benzyl-3-(2',6'-di-*iso*-propylphenyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-benzyl-3-(2',6'-di-phenylphenyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-benzyl-3-*t*-butyl-5-methoxysalicylimino)zirconium(IV) dibenzyl;

bis(2-(2H-benzotriazol-2-yl)-4,6-di-*t*-amylphenoxyde)zirconium(IV) dibenzyl; bis(2-(2H-benzotriazol-2-yl)-4,6-di-*t*-amylphenoxyde)zirconium(IV) dichloride; bis(2-(2H-benzotriazol-2-yl)-4,6-di-*t*-amylphenoxyde)zirconium(IV)
di(bis(dimethylamide));

5 bis(2-(2H-benzotriazol-2-yl)-4,6-di-(1',1'-dimethylbenzyl)phenoxyde)zirconium(IV)
dibenzyl;

 bis(2-(2H-benzotriazol-2-yl)-4,6-di-*t*-amylphenoxyde)titanium(IV) dibenzyl;
 bis(2-(2H-benzotriazol-2-yl)-4,6-di-(1',1'-dimethylbenzyl)phenoxyde)titanium(IV)
dibenzyl;

10 bis(2-(2H-benzotriazol-2-yl)-4,6-di-(1',1'-dimethylbenzyl)phenoxyde)titanium(IV)
dichloride;

 bis(2-(2H-benzotriazol-2-yl)-4,6-di-(1',1'-dimethylbenzyl)phenoxyde)hafnium(IV)
dibenzyl;

15 (N-phenyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) tribenzyl
(N-(2',6'-di-*iso*-propylphenyl)-3,5-di-(1',1'-
dimethylbenzyl)salicylimino)zirconium(IV) tribenzyl;
(N-(2',6'-di-*iso*-propylphenyl)-3,5-di-(1',1'-
dimethylbenzyl)salicylimino)titanium(IV) tribenzyl; and
(N-(2',6'-di-*iso*-propylphenyl)-3,5-di-(1',1'-
dimethylbenzyl)salicylimino)zirconium(IV) trichloride.

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8. The catalyst system of claim 6 further comprising an activator comprising one or more of an aluminum alkyl, an alumoxane, a modified alumoxane, a borane or a non-coordinating anion.

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9. The catalyst system of claim 1 wherein either the transition metal compound or the activator or both are placed on a support.

10. The catalyst system of claim 1 further comprising a Ziegler-Natta catalyst.

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11. The catalyst system of claim 1 further comprising a mono- or bis-
 cyclopentadienyl ^{Group} 4, 5 and 6 transition metal compound and an optional second activator.

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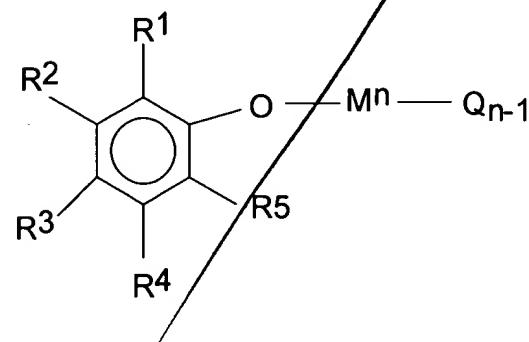
12. The catalyst system of claim 1 further comprising a second a heteroatom substituted phenoxide ^{Group} 4 to 10 transition metal compound and an optional second activator.

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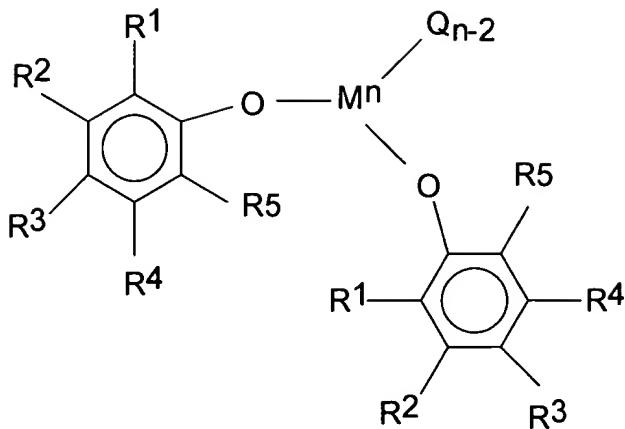
13. The catalyst system of claim 1 further comprising a second activator.

14. The catalyst system of claim 7 wherein the activator is one or more of alumoxane, tris (2, 2', 2''- nonafluorobiphenyl) fluoroaluminate, triphenyl boron, triethyl boron, tri-n-butyl ammonium tetraethylborate, triaryl borane, tri (n-butyl) ammonium tetrakis (pentafluorophenyl) boron or a trisperfluorophenyl boron, or diethylaluminum chloride.

15. A catalyst system comprising the reaction product of an activator and one or more heteroatom substituted phenoxide transition metal compounds represented by the following formulae:



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wherein:

R¹ to R⁵ may be independently hydrogen, a heteroatom containing group or a C₁ to C₁₀₀ group provided that at least one of R² to R⁵ is a group containing a heteroatom, any of R¹ to R⁵ may or may not be bound to the metal M,

O is oxygen,

M is a group 4 to 10 transition metal or a lanthanide metal,

n is the valence state of M,

Q is an anionic ligand or a bond to an R group containing a heteroatom which may be any of R¹ to R⁵, and

further provided that:

a) if M is a group 4 metal then R⁵ may not be an aldehyde or an ester;

b) if M is nickel then R⁵ may not be an imine;

c) the R⁴ and R⁵ groups do not form pyridine in the first formula if M is a group 4 metal; and

d) the R⁴ and R⁵ groups do not form pyridine in at least one ring of the second formula if M is a group 4 metal.

16. The catalyst system of claim 15 wherein the activator is an aluminum alkyl, an alumoxane, a modified alumoxane, a borane, a non-coordinating anion or a mixture thereof.

17. The catalyst system of claim 15 wherein Q is a bond to any of R² to R⁵ and the R group that Q is bound to is a heteroatom containing group.

5 18. The catalyst system of claim 15 wherein the heteroatom containing group is an imime, triazole, or oxazole.

19. The catalyst system of claim 15 wherein the heteroatom in the heteroatom containing group is nitrogen and/or oxygen.

10 20. The catalyst system of claim 15 wherein the R¹ group is a C₄ to C₂₀ alkyl group.

15 21. The catalyst system of claim 15 wherein R¹ is a tertiary alkyl group.

22. The catalyst system of claim 15 wherein R⁵ is bound to the metal.

23. The catalyst system of claim 15 wherein the R² group is a butyl, isobutyl, tertiary butyl, pentyl hexyl, heptyl, isohexyl, octyl, isoctyl, decyl, nonyl, or dodecyl group.

24. The catalyst system of claim 15 wherein two or more R groups have formed a five or six membered ring.

25 25. The catalyst system of claim 15 wherein two or more R groups have formed a multi-ring system.

26. The catalyst system of claim 15 wherein M is zirconium, titanium or hafnium.

27. The catalyst system of claim 15 wherein n is 4.

28. The catalyst system of claim 15 wherein n is 3.

5 29. The catalyst system of claim 15 wherein Q is a halogen or an alkyl group.

30. The catalyst system of claim 15 wherein Q is an amide, carboxylate, carbamate, thiolate, hydride or alkoxide group.

10 31. The catalyst system of claim 15 further comprising a support.

32. The catalyst system of claim 15 wherein either the transition metal compound or the activator or the reaction product thereof are placed on a support selected from the group consisting of talc; silica, magnesium chloride, alumina, silica-alumina; polyethylene, polypropylene, polystyrene; or a mixture thereeof.

15 33. The catalyst system of claim 32 wherein prior to being combined with the transition metal compound and/or the activator and/or the reaction product thereof the support is partially or completely dehydrated.

20 34. The catalyst system of claim 15 wherein the transition metal compound and the activator are combined in ratios of about 1000:1 to about 0.5:1.

25 35. The catalyst system of claim 15 wherein the transition metal compound and the activator are combined in ratios of about 300:1 to about 1:1.

36. The catalyst system of claim 15 wherein the activator is a borane and the transition metal compound and the borane are combined in ratios of about 1:1 to about 10:1

37. The catalyst system of claim 15 wherein the activator is an alkyl aluminum compound and the transition metal compound and the alkyl aluminum compound are combined in ratios of about 0.5:1 to about 10:1

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38. The catalyst system of claim 15 wherein two or more R groups do not form a five membered ring.

39. The catalyst system of claim 15 wherein M is zirconium.

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40. A catalyst system comprising the reaction product of an alumoxane and a one or more heteroatom substituted phenoxide transition metal compounds selected from the group consisting of:

bis(*N*-methyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;

bis(*N*-ethyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;

bis(*N*-*iso*-propyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;

bis(*N*-*t*-butyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;

bis(*N*-benzyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;

bis(*N*-hexyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;

bis(*N*-phenyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;

bis(*N*-methyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dibenzyl;

bis(*N*-benzyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dichloride;

bis(*N*-benzyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) dipivalate;

bis(*N*-benzyl-3,5-di-*t*-butylsalicylimino)titanium(IV) dipivalate;

bis(*N*-benzyl-3,5-di-*t*-butylsalicylimino)zirconium(IV) di(bis(dimethylamide));

bis(*N*-*iso*-propyl-3,5-di-*t*-amylsalicylimino)zirconium(IV) dibenzyl;

bis(*N*-*iso*-propyl-3,5-di-*t*-octylsalicylimino)zirconium(IV) dibenzyl;

bis(*N*-*iso*-propyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) dibenzyl;

bis(*N*-*iso*-propyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)titanium(IV) dibenzyl;

bis(*N*-*iso*-propyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)hafnium(IV) dibenzyl;
bis(*N*-*iso*-butyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-*iso*-butyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) dichloride;
bis(*N*-hexyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) dibenzyl;
5 bis(*N*-phenyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-*iso*-propyl-3,5-di-(1'-methylcyclohexyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-benzyl-3-*t*-butylsalicylimino)zirconium(IV) dibenzyl;
bis(*N*-benzyl-3-triphenylmethylsalicylimino)zirconium(IV) dibenzyl;
10 bis(*N*-*iso*-propyl-3-(phenyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-benzyl-3-(2',6'-di-*iso*-propylphenyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-benzyl-3-(2',6'-di-phenylphenyl)salicylimino)zirconium(IV) dibenzyl;
bis(*N*-benzyl-3-*t*-butyl-5-methoxysalicylimino)zirconium(IV) dibenzyl;
15 bis(2-(2H-benzotriazol-2-yl)-4,6-di-*t*-amylphenoxy)zirconium(IV) dibenzyl;
bis(2-(2H-benzotriazol-2-yl)-4,6-di-*t*-amylphenoxy)zirconium(IV) dichloride;
bis(2-(2H-benzotriazol-2-yl)-4,6-di-*t*-amylphenoxy)zirconium(IV)
di(bis(dimethylamide));
bis(2-(2H-benzotriazol-2-yl)-4,6-di-(1',1'-dimethylbenzyl)phenoxy)zirconium(IV)
20 dibenzyl;
bis(2-(2H-benzotriazol-2-yl)-4,6-di-*t*-amylphenoxy)titanium(IV) dibenzyl;
bis(2-(2H-benzotriazol-2-yl)-4,6-di-(1',1'-dimethylbenzyl)phenoxy)titanium(IV)
dibenzyl;
bis(2-(2H-benzotriazol-2-yl)-4,6-di-(1',1'-dimethylbenzyl)phenoxy)titanium(IV)
dichloride;
25 bis(2-(2H-benzotriazol-2-yl)-4,6-di-(1',1'-dimethylbenzyl)phenoxy)hafnium(IV)
dibenzyl;
(*N*-phenyl-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) tribenzyl
(*N*-(2',6'-di-*iso*-propylphenyl)-3,5-di-(1',1'-
dimethylbenzyl)salicylimino)zirconium(IV) tribenzyl;

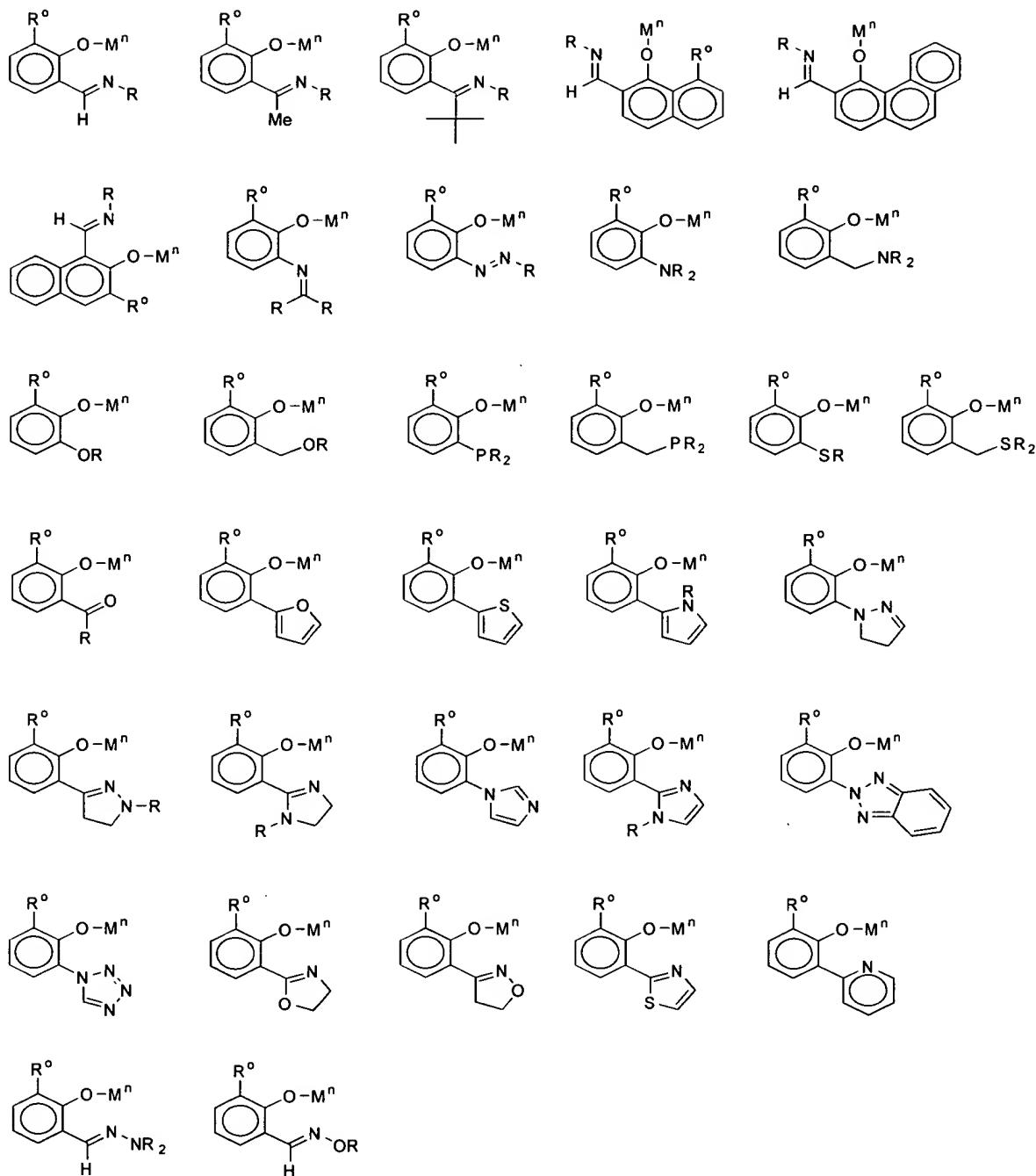
(*N*-(2',6'-di-*iso*-propylphenyl)-3,5-di-(1',1'-dimethylbenzyl)salicylimino)titanium(IV) tribenzyl; and (*N*-(2',6'-di-*iso*-propylphenyl)-3,5-di-(1',1'-dimethylbenzyl)salicylimino)zirconium(IV) trichloride.

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41. The catalyst system of claim 40 wherein the alumoxane is a modified alumoxane.

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42. A catalyst system comprising the reaction product of an activator and a one or more transition metal compounds represented by the following formulae:



provided that Mⁿ is bound to Q_{n-1}, and

R⁵ is an aldimino, ketimino, alkoxy, α -alkoxymethyl, thioalkoxy, α -

thioalkoxymethyl, amino, α -aminomethyl, azo, phosphino, α -phosphinomethyl, keto

Group

group or a pyrrole, furan, thiophene, imidazole, pyrazole, tetrazole, oxazoline, isoazole, or thiazole group,

R^o is a tertiary alkyl group or silyl group,

R is hydrogen or an alkyl, aryl, or silyl group or -OT where O is oxygen and T is hydrogen or an alkyl, aryl or silyl group,

M is a group 4 to 10 transition metal,

n is the valence state of M, and

Q is an anionic ligand.

10 43. The catalyst system of claim 42 wherein R^o is selected from the group consisting of -CMe₃, -CMe₂Et, CEt₃, -CMe₂Ph, -CPh₃, -SiMe₃, -SiEt₃, -SiPh₃, where Me is methyl, Et is ethyl and Ph is phenyl.

15 44. The catalyst system of claim 42 wherein Q is an amide, carboxylate, carbamate, thiolate, hydride or alkoxide group.

45. The catalyst system of claim 42 wherein Q is a halogen or an alkyl group.

20 46. The catalyst system of claim 42 wherein M is a ~~group~~ 4 metal.

47. The catalyst system of claim 42 wherein either the transition metal compound or the activator or both or the reaction product thereof are placed on a support.

25 48. The catalyst system of claim 47 wherein the support is talc; silica, magnesium chloride, alumina, silica-alumina; polyethylene, polypropylene, polystyrene; or a mixture thereof.

49. The catalyst system of claim 47 wherein prior to being combined with the transition metal compound and/or the activator the support is partially or completely dehydrated.

5 50. A catalyst system comprising one or more heteroatom substituted phenoxide group 4 to 10 transition metal or lanthanide metal compounds wherein the metal is bound to the oxygen of the phenoxide group and provided that:

a) if more than one heteroatom substituted phenoxide is present it is not bridged to the other heteroatom substituted phenoxide,

10 b) if the metal is a group 4 metal, the heteroatom substituted phenoxide does not contain pyridine,

c) if the metal is a group 4 metal then the carbon ortho to the carbon bound to the oxygen of the phenoxide may not be bound to an aldehyde or an ester, and

15 d) if the metal is nickel then the carbon ortho to the carbon bound to the oxygen of the phenoxide may not be bound to an imine.

51. The catalyst system of claim 50 wherein the transition metal is a group 4 metal.

20 52. The catalyst system of claim 50 wherein the transition metal is zirconium, hafnium or titanium.

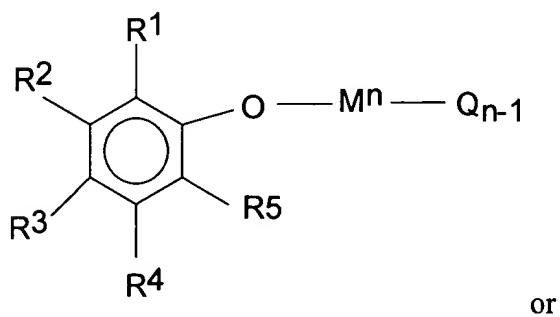
53. The catalyst system of claim 50 wherein the heteroatom substituted phenoxide transition metal compound is an iminophenoxide group 4 transition metal compound.

25 54. The catalyst system of claim 50 wherein the heteroatom substituted phenoxide transition metal compound is an iminophenoxydezirconium compound.

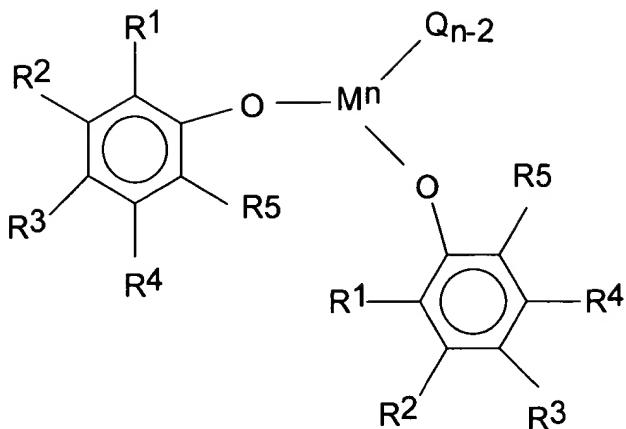
25. A process for polymerizing olefins comprising combining one or more olefins with a catalyst system comprising the reaction product of one or more activators and one or more heteroatom substituted phenoxide group 4 to 10 transition metal or lanthanide metal compounds wherein the metal is bound to the oxygen of the phenoxide group and provided that:

- a) if more than one heteroatom substituted phenoxide is present it is not bridged to the other heteroatom substituted phenoxide,
- b) if the metal is a group 4 metal, the heteroatom substituted phenoxide does not contain pyridine,
- c) if the metal is a group 4 metal then the carbon ortho to the carbon bound to the oxygen of the phenoxide may not be bound to an aldehyde or an ester, and
- d) if the metal is nickel then the carbon ortho to the carbon bound to the oxygen of the phenoxide may not be bound to an imine.

15 56. The process of claim 55 wherein the heteroatom substituted phenoxide transition metal compound is represented by the of the following formulae:



or



wherein:

R¹ to R⁵ may be independently hydrogen, a heteroatom containing group or a C₁ to C₁₀₀ group provided that at least one of R² to R⁵ is a group containing a heteroatom, any of R¹ to R⁵ may or may not be bound to the metal M,

O is oxygen,

M is a group 4 to 10 transition metal or a lanthanide metal,

n is the valence state of M,

Q is an anionic ligand or a bond to an R group containing a heteroatom which may be any of R¹ to R⁵, and

further provided that:

- a) if M is a group 4 metal then R⁵ may not be an aldehyde or an ester;
- b) if M is nickel then R⁵ may not be an imine;
- c) the R⁴ and R⁵ groups do not form pyridine in the first formula if M is a group 4 metal; and
- d) the R⁴ and R⁵ groups do not form pyridine in at least one ring of the second formula if M is a group 4 metal.

57. The process of claim 55 wherein the activator is an aluminum alkyl, an

20 alumoxane, a modified alumoxane, a borane, a non-coordinating anion or a mixture thereof.

58. The process of claim 56 wherein Q is a bond to any of R² to R⁵ and the R group that Q is bound to is a heteroatom containing group.

5 59. The process of claim 55 wherein the heteroatom containing group is an imime, triazole, or oxazole.

60. The process of claim 55 wherein the heteroatom in the heteroatom containing group is nitrogen and/or oxygen.

10 61. The process of claim 56 wherein the R¹ group is a C₄ to C₂₀ alkyl group.

62. The process of claim 56 wherein the R¹ group is a butyl, isobutyl, pentyl hexyl, heptyl, isohexyl, octyl, isoctyl, decyl, nonyl, or dodecyl group.

15 63. The process of claim 56 wherein two or more R groups have formed a five or six membered ring.

20 64. The process of claim 56 wherein two or more R groups have formed a multi ring system.

65. The process of claim 56 wherein M is zirconium, titanium or hafnium.

66. The process of claim 56 wherein n is 3 or 4.

25 67. The process of claim 56 wherein Q is a halogen or an alkyl group.

68. The process of claim 56 wherein Q is an amide, carboxylate, carbamate, thiolate, hydride or alkoxide group.

69. The process of claim 55 wherein the catalyst system and the olefin are reacted in the gas phase.

5 70. The process of claim 55 wherein the catalyst system and the olefin are reacted in the slurry phase.

71. The process of claim 55 wherein the catalyst system and the olefin are reacted in the slurry phase solution phase.

10 72. The process of claim 55 wherein the catalyst system and the olefin are reacted under high pressure.

15 73. A library of a plurality of heteroatom substituted phenoxide group 4 to 10 transition metal or lanthanide metal compounds wherein the metal is bound to the oxygen of the phenoxide group and provided that:

a) if more than one heteroatom substituted phenoxide is present it is not bridged to the other heteroatom substituted phenoxide,

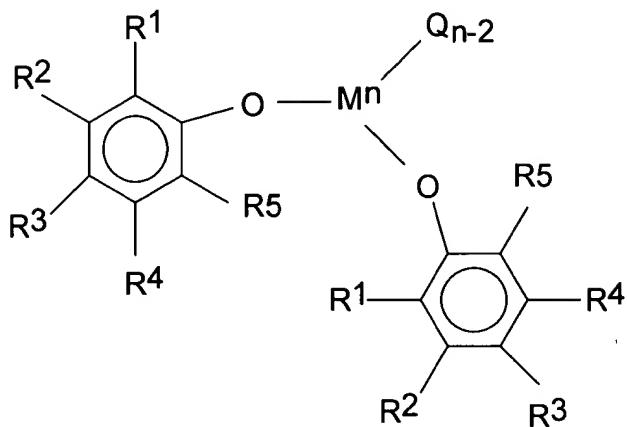
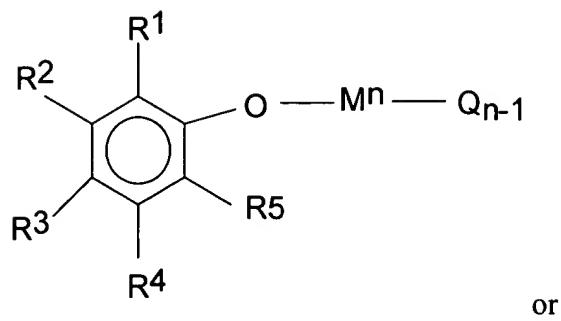
b) if the metal is a group 4 metal, the heteroatom substituted phenoxide does not contain pyridine,

c) if the metal is a group 4 metal then the carbon ortho to the carbon bound to the oxygen of the phenoxide may not be bound to an aldehyde or an ester, and

d) if the metal is nickel then the carbon ortho to the carbon bound to the oxygen of the phenoxide may not be bound to an imine.

20 25 74. A process for the simultaneous parallel screening of catalysts comprising combining the library of claim 73 with one or more olefins.

75. A library of a plurality of compounds represented by the following formulae:



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wherein:

R¹ to R⁵ may be independently hydrogen, a heteroatom containing group or a C₁ to C₁₀₀ group provided that at least one of R² to R⁵ is a group containing a heteroatom,
R¹ to R⁵ may or may not be bound to the metal M,

O is oxygen,

M is a group 4 to 10 transition metal or lanthanide metal,

n is the valence state of M,

Q is an anionic ligand or a bond to an R group containing a heteroatom which may be any of R¹ to R⁵, and

further provided that:

- a) if M is a group 4 metal then R⁵ may not be an aldehyde or an ester;
- b) if M is nickel then R⁵ may not be an imine;

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- c) the R⁴ and R⁵ groups do not form pyridine in the first formula if M is a group 4 metal; and
- d) the R⁴ and R⁵ groups do not form pyridine in at least one ring of the second formula if M is a group 4 metal.

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76. A process for the simultaneous parallel screening of catalysts comprising combining the library of claim 75 with one or more olefins.